

CLAIMS

What is claimed is:

1. An automated tool installation and workspace analysis method comprising:

calculating a center of gravity of a fastener;

determining an axis of the fastener based at least partially on the center of gravity; and

determining positioning of a fastener actuating tool according to the axis of the fastener.

2. The method of claim 1 wherein determining the axis includes determining the axis based on a relationship between an initial axis and vertices of the fastener.

3. The method of claim 1 wherein determining the axis includes:

assuming an initial axis;

rotating the initial axis; and

adjusting the initial axis based on a relationship between the initial axis and vertices of the fastener.

4. The method of claim 3 wherein the assuming includes assuming an initial axis of $L(c, V)$, where c is the center of gravity of the fastener, V is $(1, 0, 0)$, and L is a line through c having direction V .

5. The method of claim 3 wherein the rotating includes rotating the initial axis in at least one direction about at least one axis.

6. The method of claim 4 wherein the relationship is a distance between each vertex and the line $L(c, V)$.

7. The method of claim 1 further comprising rotating the tool about the axis to determine a tool-rotation envelope.

8. A graphical user interface that implements the method of claim 1.

9. An automated tool installation and workspace analysis method comprising:

- determining geometry of a fastener in an environment;
- calculating a center of gravity of the fastener; and
- determining an axis of the fastener based at least partially on the geometry of the fastener and the center of gravity.

10. The method of claim 9 wherein determining the geometry includes determining vertices of the fastener.

11. The method of claim 10 wherein determining the axis includes:

assuming an initial axis of the fastener; and

adjusting the initial axis based on a relationship between an initial axis and vertices of the fastener.

12. The method of claim 11 wherein the adjusting includes:

rotating the initial axis in at least one direction;

calculating an updated relationship between the rotated axis and the vertices of the fastener; and

adjusting the initial axis based on the updated relationship.

13. The method of claim 11 wherein the assuming includes assuming an initial axis of $L(c, V)$, where c is the center of gravity of the fastener, V is a direction $(1, 0, 0)$, and L is a line through c having direction V .

14. The method of claim 12 wherein the step of rotating includes rotating the initial axis in at least one direction about at least one of an x axis, a y axis, and a z axis.

15. The method of claim 11 wherein the relationship is a distance between each vertex and the initial axis.